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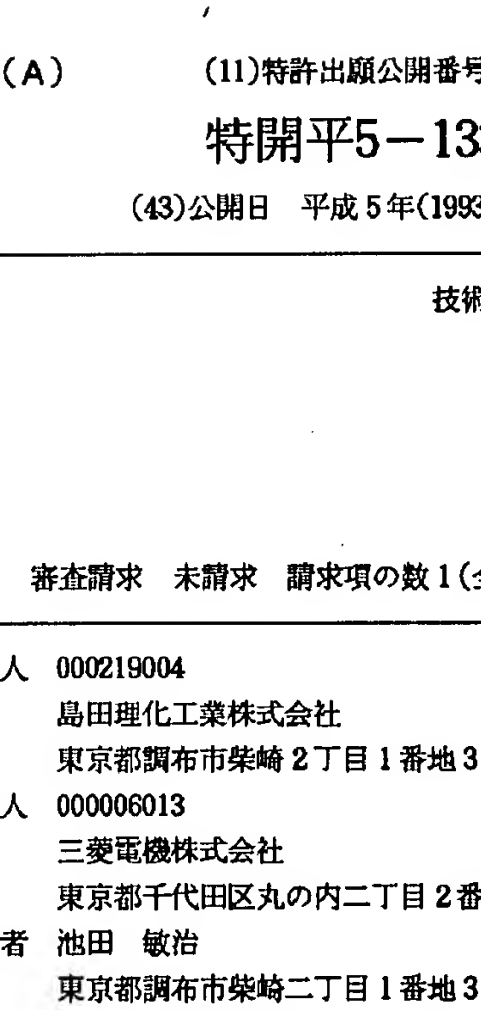
(54)【発明の名称】　半導体装置の洗浄方法

(57)【要約】
【目的】　半導体ウエハの表面や半導体ウエハに形成された穴、溝内にある異物を超音波のエネルギーの助けにより剥離し、液体の分子運動により異物を外部に排出し、異物を完全に除去するものである。
【構成】　半導体ウエハに形成された穴や溝に対し、水平成分と垂直成分を持つ超音波を照射し、液体分子を振動させて洗浄するものである。



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【特許請求の範囲】
【請求項１】　半導体ウエハに形成された穴や溝に対し、水平成分と垂直成分を持つ超音波を照射し、液体分子を振動させて洗浄することを特徴とする半導体装置の洗浄方法。
【発明の詳細な説明】
【０００１】
【産業上の利用分野】この発明は半導体装置の洗浄方法に関し、特に半導体ウエハに形成された穴や溝内に付着した異物を除去することができる半導体装置の洗浄方法に関する。
【０００２】
【従来の技術】近時、半導体装置例えば半導体集積回路の微細化が進み、半導体ウエハの表面に形成される回路の構造が複雑になり、表面のおおとつが激しくなってきている。このため、図５に示すように異物１が半導体ウエハ２の表面に形成されたトレンチ穴３の開口部近傍や中間部以降の壁面に沿って残る。そこで、半導体集積回路を製造する各工程において、ウエハ表面上の異物１を除去するのみではなく、おおとつの激しい部分例えばアスペクト比の大きさが数十程度のトレンチ穴や溝内における異物も確実に除去する必要があり、例えば純水リンスを用いて６０分洗浄したのち自乾した場合、図６（ａ）に示すようにウエハ表面に付着していたパーテイクルが剥離しているが、異物１がいぜんとして残っている。また、ＳＣ－１で５分、純水リンスで５分洗浄したのち自乾した場合、図６（ｂ）に示すように半導体ウエハ２の表面には異物１が無くなるが、トレンチ穴３内にはいぜんとして残っている。
【０００３】
【発明が解決しようとする課題】しかしながら、上述した従来の半導体装置の洗浄方法はトレンチ穴の中の異物を完全に除去する有効な手段がなく、いぜんとして異物が残るという問題点があった。この発明は上記のような問題点を解消するためになされたもので、超音波による洗浄液の分子運動により半導体ウエハの表面、穴および溝の内にある異物を除去することを目的とする。
【０００４】
【課題を解決するための手段】この発明に係る半導体装置の洗浄方法は、半導体ウエハに形成された穴や溝に対し、水平成分と垂直成分を持つ超音波を照射し、液体分子を振動させて洗浄するものである。
【０００５】
【作用】この発明は半導体ウエハの表面、穴および溝の内にある異物を、超音波のエネルギーの助けにより、洗浄液の分子運動（異物と同程度の大きさ）により、穴、溝の内から外に出したのち、外部へ完全に除去することができる。
【０００６】
【実施例】図１はこの発明に係る半導体装置の洗浄方法

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の一実施例を示す図であり、特に図１（ａ）はその断面側面図、図１（ｂ）および図１（ｃ）は図１（ａ）における洗浄動作を説明するための図である。同図において、４は洗浄液５を入れた洗浄槽、６はこの洗浄槽４の壁面に取り付けられ、超音波７を出力する超音波発振器であり、一例として、超音波７が半導体ウエハ２の表面に所定の角度で照射するように超音波発振器６を取り付けた場合であり、一例として洗浄槽４の取付け壁面を傾斜させて、超音波発振器６を取り付けた場合である。
【０００７】次に上記構成による半導体装置の洗浄方法、特にトレンチ穴３の内を洗浄し、異物を除去する動作について図１（ｂ）および図１（ｃ）を参照して説明する。まず、トレンチ穴３をもつ半導体ウエハ２の表面から見ると、超音波７は図１（ｂ）に示すようにトレンチ穴３に対し水平成分７ａと垂直成分７ｂとに分けることができる。したがって、この超音波７の水平成分７ａは図１（ｃ）に示すように、トレンチ穴３内の洗浄液５を水平方向８ａに振動させて、トレンチ３内の異物１を剥離させ、トレンチ穴３の外に異物を排出する。一方、超音波７の垂直成分７ｂは図１（ｃ）に示すようにトレンチ穴３内の洗浄液５を垂直方向８ｂに振動し、半導体ウエハ２の表面に排出された異物１を半導体ウエハ２の表面から遠ざけるように作用する。
【０００８】なお、半導体ウエハ２に対する超音波発振器６の取り付け角度は２０度～７０度程度にすることにより、トレンチ穴３内の異物１を効率よく剥離し、排出することができる。図７では（ＳＣ－１）＋（ＭＳ）で１０分洗浄し、そして純水リンスで５分洗浄したのち自乾した場合であり、トレンチ３内および半導体ウエハ表面共にパーテイクルの残留はなしである
【０００９】図２はこの発明に係る半導体装置の洗浄方法の他の実施例を示す図であり、特に図２（ａ）はその断面側面図、図２（ｂ）および図２（ｃ）は図２（ａ）における洗浄動作を説明するための図である。同図において。９ａ～９ｄはトレンチ穴３に対して水平方向の超音波１０を出力する第１超音波発振器、１１はトレンチ穴３に対して垂直方向の超音波１２を出力する第２超音波発振器である。なお、半導体ウエハ２の表面に付着した異物およびトレンチ穴３内にある異物１を剥離し、除去する動作は図１の動作と同様であることはもちろんである。
【００１０】次に、トレンチ穴３内の異物１を除去するための超音波の周波数（ＭＨＺ）とパワー（Ｗ／㎠）の関係を図３および図４を参照して説明する。まず、トレンチ穴３の中の異物１を除去するためには、（Ａ）トレンチ穴３内に洗浄液５の分子流１３にエネルギーを伝えるため、トレンチ穴３の径より小さい振動幅をもつ超音波、（Ｂ）　洗浄液５の分子流１３によりトレンチ穴３内の異物１を振動させて剥離させることおよびトレンチ穴３の洗浄液５の分子流１３により洗浄液５のかく

拌を加速し、トレンチ穴3の外へ異物1を排出するため、半導体ウエハ2の表面に垂直（トレンチ穴3に対して水平）で、かつ異物1と同程度の振動幅をもつ超音波、（C）　半導体ウエハ2の表面に排出された異物1を洗浄液5の分子流13により半導体ウエハ2の表面における洗浄液5のかく拌を加速し、半導体ウエハ2の表面より遠ざけるため、半導体ウエハ2の表面に水平（トレンチ穴3に対して垂直）でかつ異物1と同程度の振動幅をもつ超音波により可能である。そこで、超音波の音響パワー（I：W／cm²）と周波数（f）と洗浄液5の分子振動幅（A：cm）との関係は下記に示すことができる。

【0011】$I = PC(2\pi fA)^2/2$

ただし、Pは洗浄液（5）の密度（g／cm³）（水の場合は1）

Cは音速（cm／S）（水の場合は1.5×10^5（cm／S））

【0012】1μmの幅のトレンチ穴3内の0．06μm異物1を効率よく取り除くとして、0．06μmの液分子振動幅を得るためには上記の式から周波数800KHz，音響パワー7．5W／cm² が必要である。そして、振動幅0．01μm，0．06μm，0．5μmを得る場合の周波数と音響パワーとの関係を図4に示す。また、1μmの幅のトレンチ穴（3）内の異物（0．5μm～0．01μm）を取り除くには100KHz～10MHzの周波数と0．01～4，000W／cm²の音響エネルギーをトレンチ穴3に対して、垂直成分および水平成分を持つ超音波をウエハ表面に加える必要がある。

【0013】

【発明の効果】以上詳細に説明したように、この発明に係る半導体装置の洗浄方法によれば、半導体ウエハに形

成された穴、溝内および表面に付着した異物を超音波および液流による液の運動エネルギーで剥離し、外部に完全に排出することができる効果がある。

【図面の簡単な説明】

【図1】この発明に係る半導体装置の洗浄方法の一実施例を示す図である。

【図2】この発明に係る半導体装置の洗浄方法の他の実施例を示す図である。

【図3】半導体ウエハのトレンチ穴内の異物除去の方法を示す図である。

【図4】液の分子振動幅と超音波音響エネルギー，周波数との関係を示す図である。

【図5】トレンチ穴内にある異物の標準汚染サンプルを示す図である。

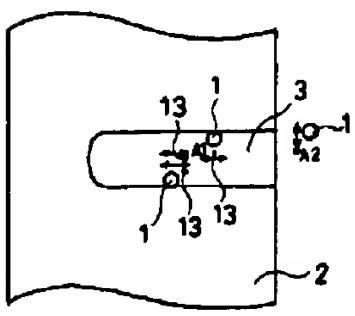
【図6】従来の半導体装置の洗浄方法によりトレンチ穴内およびウエハ表面を洗浄した場合を示す図である。

【図7】この発明に係る半導体装置の洗浄方法によりトレンチ穴内およびウエハ表面を洗浄した場合を示す図である。

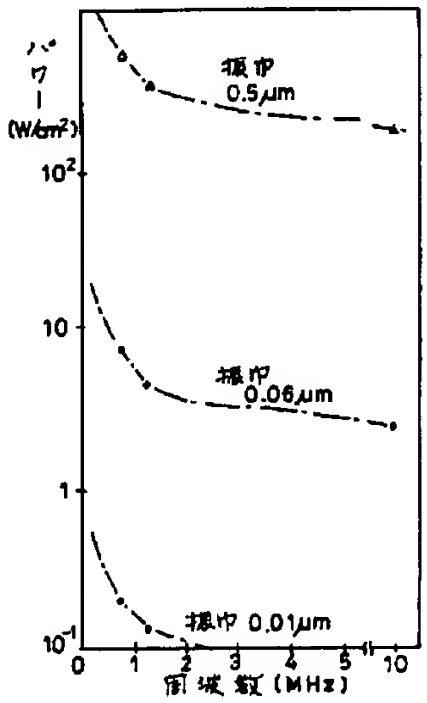
【符号の説明】

1　異物
2　半導体ウエハ
3　トレンチ穴
4　洗浄槽
5　洗浄液
6　超音波発振器
7　超音波
8a，8b　洗浄液の振動方向
10，12　超音波
9a～9b，11　超音波発振器

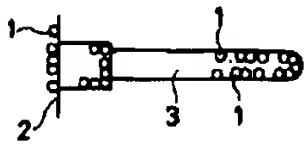
【図3】



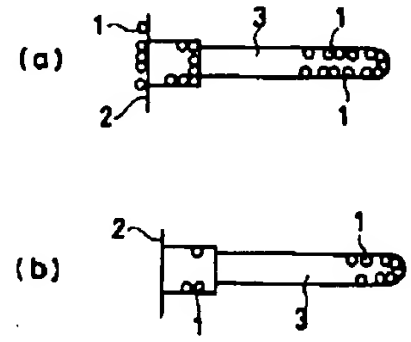
【図4】



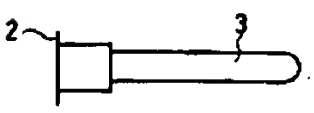
【図5】



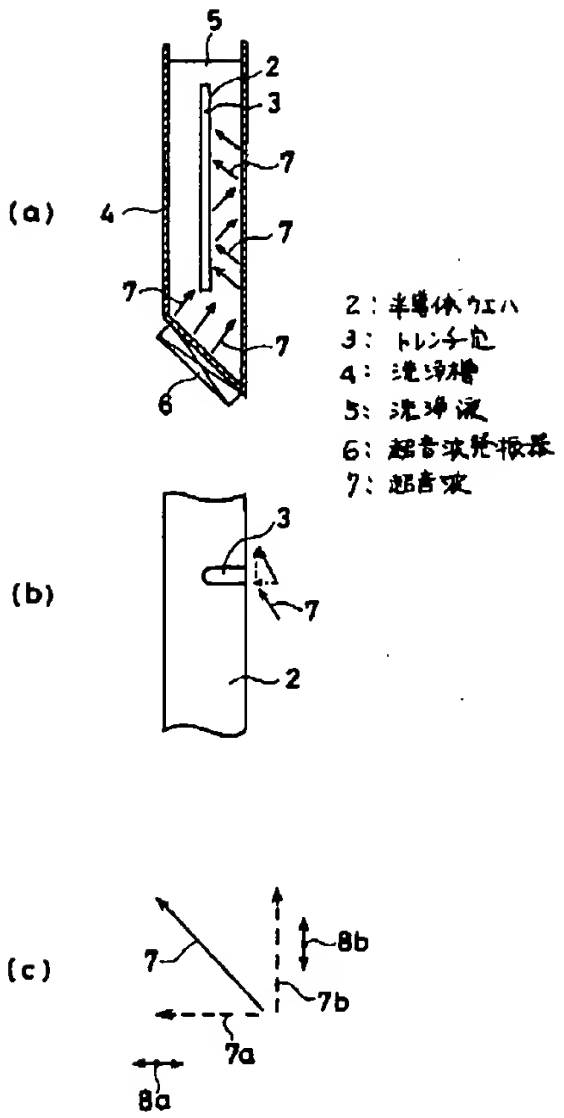
【図6】



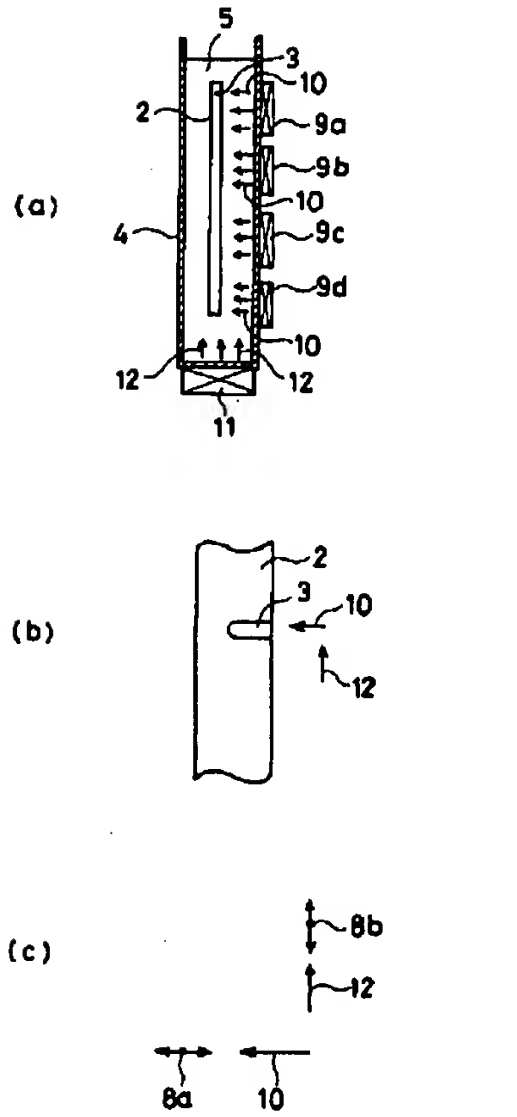
【図7】



【図1】


(a)
(b)
(c)
5
2
3
7
4
6
7a
8b
7b
8a
2：半導体ウエハ
3：トレンチ穴
4：洗浄槽
5：洗浄液
6：超音波発振器
7：超音波

【図2】


(a)
(b)
(c)
5
3
10
2
9a
9b
10
4
9c
9d
10
12
12
11
2
3
10
12
8b
12
8a
10

PATENT ABSTRACTS OF JAPAN

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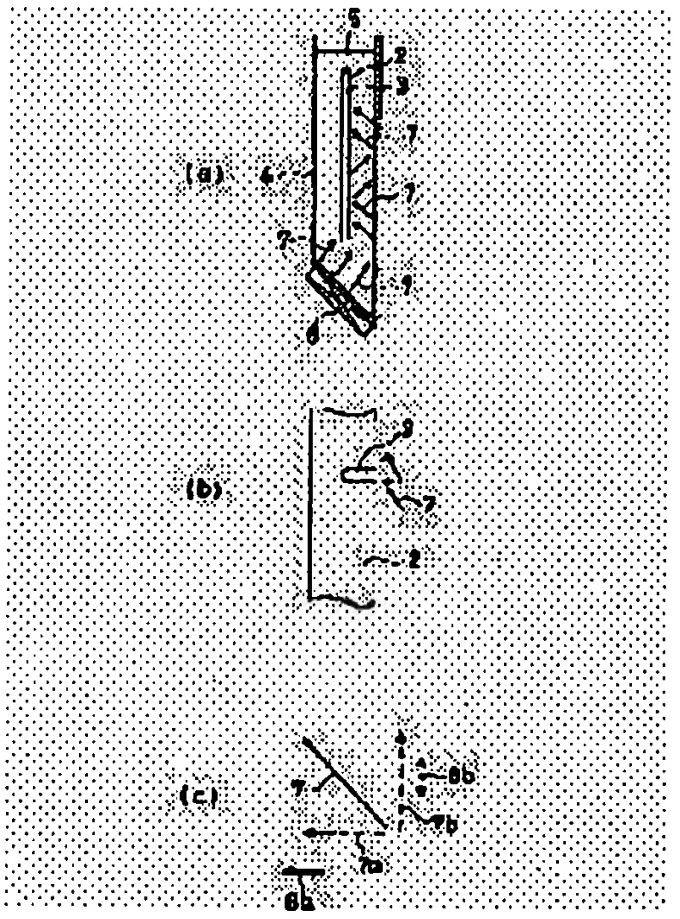
(54) CLEANING METHOD FOR SEMICONDUCTOR DEVICE

(57)Abstract:

PURPOSE: To remove completely foreign substances by a method wherein a hole or a groove formed in a semiconductor wafer is irradiated with ultrasonic waves, each having a horizontal component and a vertical component, and the foreign substances are discharged outside by the molecular motion of a liquid.

CONSTITUTION: An ultrasonic oscillator 6 is mounted on the wall surface of a cleaning tank 4, in which a cleaning liquid 5 is put. The oscillator 6 is mounted in such a way that the surface of a semiconductor wafer 2 is irradiated with ultrasonic waves 7 at a prescribed angle. For example, the mounting wall surface of the tank 4 is slanted to mount the oscillator 6. The waves 7 respectively have a horizontal component 7a and a vertical component 7b to a trench hole 3 as seen from the surface of the wafer 2 having the trench hole 3. The component 7a makes the liquid 5 in the hole 3 vibrate in horizontal directions 8a to eliminate foreign substances in the hole 3. The component 7b makes the liquid 5 in the hole 3 vibrate in vertical directions 8b to keep foreign substances discharged on the surface of the wafer 2 away from the surface of the wafer 2. Thereby, residues of particles in the hole 3 and on the wafer surface are eliminated.



LEGAL STATUS

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[Date of sending the examiner's decision of rejection]	30.11.1999
[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]	
[Date of final disposal for application]	
[Patent number]	
[Date of registration]	
[Number of appeal against examiner's decision of rejection]	
[Date of requesting appeal against examiner's decision of rejection]	
[Date of extinction of right]	

* NOTICES *

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CLAIMS

[Claim(s)]
[Claim 1] The washing approach of the semiconductor device characterized by irradiating a supersonic wave with a horizontal component and a vertical component to the hole and slot which were formed in the semi-conductor wafer, vibrating a liquid molecule, and washing.

[Translation done.]

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] Especially this invention relates to the washing approach of a semiconductor device that the foreign matter adhering to the hole formed in the semi-conductor wafer or Mizouchi is removable, about the washing approach of a semiconductor device.
[0002]
[Description of the Prior Art] the structure of the circuit which detailed-ization of a semiconductor device, for example, a semiconductor integrated circuit, progresses recently, and is formed in the front face of a semi-conductor wafer -- complicated -- becoming -- a front face -- **** -- a convex is becoming intense. For this reason, it remains along with the wall surface after the pars intermedia near the opening of the trench hole 3 where the foreign matter 1 was formed in the front face of the semi-conductor wafer 2 as shown in drawing 5 . In each process which manufactures a semiconductor integrated circuit then, it not only removes the foreign matter 1 on a wafer front face, but It is necessary to also remove certainly the foreign matter in the trench hole and Mizouchi whose magnitude of the intense part of a convex, for example, an aspect ratio, is about dozens. **** -- For example, although the particle adhering to a wafer front face has exfoliated as shown in drawing 6 (a) when [which was washed for 60 minutes using the pure-water rinse] it after self-**, the foreign matter 1 still carried out and remains. Moreover, although a foreign matter 1 is lost in the front face of the semi-conductor wafer 2 as shown in drawing 6 (b) when [which was washed with the pure-water rinse by SC-1 for 5 minutes for 5 minutes] it after self-**, in the trench hole 3, it still carried out and remains.
[0003]
[Problem(s) to be Solved by the Invention] However, the washing approach of the conventional semiconductor device mentioned above does not have an effective means to remove the foreign matter in a trench hole completely, and had the trouble that still carried out and a foreign matter remained. This invention was made in order to cancel the above troubles, and it aims at removing the foreign matter which is in the inside of the front face of a semi-conductor wafer, a hole, and a slot by the molecular motion of the penetrant remover by the supersonic wave.
[0004]
[Means for Solving the Problem] The washing approach of the semiconductor device concerning this invention irradiates a supersonic wave with a horizontal component and a vertical component to the hole and slot which were formed in the semi-conductor wafer, vibrates a liquid molecule, and is washed.
[0005]
[Function] With the help of the energy of a supersonic wave, by the molecular motion (magnitude comparable as a foreign matter) of a penetrant remover, this invention can remove it completely to the exterior, after taking out the foreign matter in the inside of the front face of a semi-conductor wafer, a hole, and a slot from from outside among a hole and a slot.
[0006]
[Example] Drawing 1 is drawing showing one example of the washing approach of the semiconductor

device concerning this invention, and especially drawing 1 (a) is drawing for that cross-section side elevation, drawing 1 (b), and drawing 1 (c) to explain the washing actuation in drawing 1 (a). The cleaning tank into which 4 put the penetrant remover 5 in this drawing, and 6 are the cases where were the ultrasonic wave oscillator which outputs a supersonic wave 7, are the case where an ultrasonic wave oscillator 6 is attached, made the anchoring wall surface of a cleaning tank 4 to have been attached in the wall surface of this cleaning tank 4, and incline as an example so that a supersonic wave 7 may irradiate the front face of the semi-conductor wafer 2 at an angle of predetermined as an example, and an ultrasonic wave oscillator 6 is attached.

[0007] Next, the inside of the washing approach of the semiconductor device by the above-mentioned configuration, especially the trench hole 3 is washed, and the actuation which removes a foreign matter is explained with reference to drawing 1 (b) and drawing 1 (c). First, if it sees from the front face of the semi-conductor wafer 2 with the trench hole 3, a supersonic wave 7 can be divided into horizontal component 7a and vertical component 7b to the trench hole 3, as shown in drawing 1 (b). Therefore, as shown in drawing 1 (c), horizontal component 7a of this supersonic wave 7 vibrates the penetrant remover 5 in the trench hole 3 to horizontal direction 8a, makes the foreign matter 1 in a trench 3 exfoliate, and discharges a foreign matter outside the trench hole 3. On the other hand, vertical component 7b of a supersonic wave 7 vibrates the penetrant remover 5 in the trench hole 3 to perpendicular direction 8b, as shown in drawing 1 (c), and it acts so that the foreign matter 1 discharged by the front face of the semi-conductor wafer 2 may be kept away from the front face of the semi-conductor wafer 2.

[0008] In addition, by making it 20 - about 70 degrees, whenever [setting-angle / of the ultrasonic wave oscillator 6 to the semi-conductor wafer 2] exfoliates efficiently, and can discharge the foreign matter 1 in the trench hole 3. It is [0009] without the inside of a trench 3 and a semi-conductor wafer front face. [at drawing 7 , wash by (SC-1)+ (MS) for 10 minutes, and are the case washed with the pure-water rinse for 5 minutes where it after self-**, and] [the residual of particle] Drawing 2 is drawing showing other examples of the washing approach of the semiconductor device concerning this invention, and especially drawing 2 (a) is drawing for that cross-section side elevation, drawing 2 (b), and drawing 2 (c) to explain the washing actuation in drawing 2 (a). Set to this drawing. The 1st ultrasonic wave oscillator which outputs the horizontal supersonic wave 10 to the trench hole 3 9a-9d, and 11 are the 2nd ultrasonic wave oscillator which outputs the vertical supersonic wave 12 to the trench hole 3. In addition, as for the actuation which exfoliates and removes the foreign matter 1 in the foreign matter adhering to the front face of the semi-conductor wafer 2, and the trench hole 3, it is needless to say that it is the same as that of actuation of drawing 1 .

[0010] Next, the frequency (MHZ) of the supersonic wave for removing the foreign matter 1 in the trench hole 3 and the relation of power (W/cm2) are explained with reference to drawing 3 and drawing 4 . first, in order to remove the foreign matter 1 in the trench hole 3 (A) In order to tell energy to the molecular flow 13 of a penetrant remover 5 into the trench hole 3, Supersonic wave with oscillating width of face smaller than the path of the trench hole 3 (B) ** which a penetrant remover 5 writes by the molecular flow 13 of the penetrant remover 5 of vibrating the foreign matter 1 in the trench hole 3 by the molecular flow 13 of a penetrant remover 5, and making it exfoliate and the trench hole 3 is accelerated. In order to discharge a foreign matter 1 out of the trench hole 3, on the front face of the semi-conductor wafer 2 by the perpendicular (level to the trench hole 3) And supersonic wave with oscillating width of face comparable as a foreign matter 1 (C) ** which the penetrant remover 5 in the front face of the semi-conductor wafer 2 writes the foreign matter 1 discharged by the front face of the semi-conductor wafer 2 by the molecular flow 13 of a penetrant remover 5 is accelerated. Since it keeps away from the front face of the semi-conductor wafer 2, it is possible by the supersonic wave with oscillating width of face comparable as a foreign matter 1 at a level with the front face of the semi-conductor wafer 2 (perpendicular to the trench hole 3). Then, sound power of a supersonic wave (I:W/cm2) The relation between a frequency (f) and the molecular vibration width of face (A:cm) of a penetrant remover 5 can be shown below.

[0011] I=PC (2pifA) 2/2, however P are the consistency (g/cm3) (in the case of water, it is 1) of a

penetrant remover (5).
C is acoustic velocity (cm/S) (in the case of water, it is 1.5x105 (cm/S)).
[0012] The frequency of 800kHz from the above-mentioned formula and sound power 7.5 W/cm2 in order to obtain liquid molecular vibration width of face of 0.06 micrometers noting that the 0.06-micrometer foreign matter 1 in the 1-micrometer trench hole 3 of width of face is removed efficiently It is required. And the relation between the frequency in the case of obtaining oscillating width of face of 0.01 micrometers, 0.06 micrometers, and 0.5 micrometers and sound power is shown in drawing 4 . Moreover, it is necessary to add the supersonic wave which has a vertical component and a horizontal component for the sound energy of the frequency of 100kHz - 10MHz, and 0.01 - 4,000 W/cm2 to the trench hole 3 for removing the foreign matter (0.5 micrometers - 0.01 micrometers) in the 1-micrometer trench hole (3) of width of face to a wafer front face.
[0013]
[Effect of the Invention] As explained to the detail above, according to the washing approach of the semiconductor device concerning this invention, there is effectiveness which exfoliates with the kinetic energy of the liquid by the supersonic wave and the liquid flow, and can discharge completely outside the foreign matter adhering to the hole, Mizouchi, and the front face which were formed in the semi-conductor wafer.

[Translation done.]

* NOTICES *

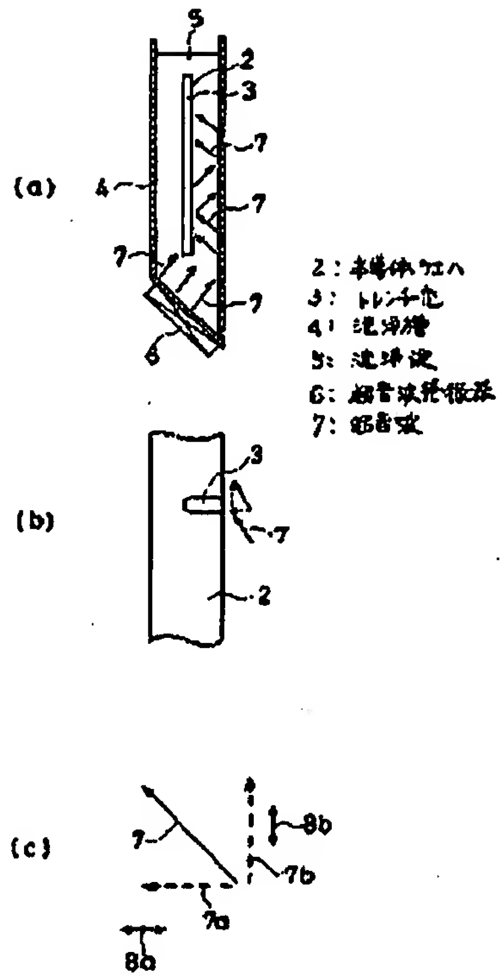
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is drawing showing one example of the washing approach of the semiconductor device concerning this invention.
[Drawing 2] It is drawing showing other examples of the washing approach of the semiconductor device concerning this invention.
[Drawing 3] It is drawing showing the approach of tailing in the trench hole of a semi-conductor wafer.
[Drawing 4] It is drawing showing the relation between the molecular vibration width of face of liquid, and ultrasonic sound energy and a frequency.
[Drawing 5] It is drawing showing the standard contamination sample of the foreign matter in a trench hole.
[Drawing 6] It is drawing showing the case where the inside of a trench hole and a wafer front face are washed by the washing approach of the conventional semiconductor device.
[Drawing 7] It is drawing showing the case where the inside of a trench hole and a wafer front face are washed by the washing approach of the semiconductor device concerning this invention.
[Description of Notations]
1 Foreign Matter
2 Semi-conductor Wafer
3 Trench Hole
4 Cleaning Tank
5 Penetrant Remover
6 Ultrasonic Wave Oscillator
7 Supersonic Wave
8a, 8b The oscillating direction of a penetrant remover
10 12 Supersonic wave
9a- 9b and 11 Ultrasonic wave oscillator

[Translation done.]

【図1】



【図2】